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Research Aticle

Challenges of Increasing Student Intake in Engineering Disciplines the Case of University of Mines and Technology, Tarkwa

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Abstract: For efficient and effective practice of engineering, people who aspire to be engineers should be groomed in an environment where quality is assured. In Ghana, the need to train more engineers and governments policy of increasing student's intake by about 10% each year has raised the number of student's enrolment in all the engineering disciplines to higher levels. Over the past 25 years, the University of Mines and Technology (UMaT), with its strategic location, industrial environment, good academic facilities and capable staff has been an excellent place for training graduates of proven ability in the engineering disciplines. However, the problem of increasing student's intake in the engineering discipline with the limited resources had been a major challenge. UMaT has produced a high caliber of engineering graduate in the mining and its allied disciplines. Student enrolment in the University has seen a gradual increase from the early 1990's to date. With increasing students' intake and the slow level of infrastructural development, lecture theatres cannot cater for combined classes for courses being undertaken by students. This has resulted in pressure on academic facilities such as lecture rooms, laboratories, libraries and computers. This also implies an additional work for technicians, laboratory assistant and lecturers handling such students. It is important that government and stake holders in the tertiary education restructure and provide more funding for engineering education. The study looks at the challenges of increasing student intake in the engineering discipline and effort to be made in solving these problems. To provide an in-depth analysis to the issue at stake, available literatures were examined, available facilities were assessed and a general interaction with stakeholders including students, laboratory technicians, lecturers and administrators were employed. A number of recommendations were made to deal with the problems among which are managing the class sizes, improving the residential facilities, teaching facilities, infrastructural development and improving the University/industrial relationship.

Keywords: Academic facilities, engineering discipline, student intake

INTRODUCTION

Engineering has played a critical role in increasing the health, technology and quality of life of humans in the last 50 years (Cortese and Camp, 1998). Engineering education is the activity of teaching knowledge and principles related to the professional practice of engineering. It includes the initial education for becoming an engineer and any advanced education and specialization that follow.

From developing new equipments and goods, power systems, weapons, new materials, vehicles which transports people and goods on ground, water and air, better water supplies, design of buildings to protect us from natural hazards and provide health care, improved agriculture, transportation systems, basic infrastructure on which modern society depends, power plants which give electrical power to do daily work and run industry. The current model of "engineering for development"-development with technology at the core-promotes engineers as unilateral leaders who should be embedded into a larger team focused on policy, local context and education (Nieusma, 2010).

In the popular mind, scientists and engineers have distinct job descriptions. Scientists explore, experiment and discover; engineers create, design and build. Traditional engineering education strategies focus largely on the delivery of fundamental engineering principles of core and important subjects which are subsequently leveraged on the design of new products and technological solutions. However, with rapid advancement of new technologies, increase in global and accelerated time based competition, high density of population and demand for complex solutions; such approaches have become questionable in terms of production of engineers with keen eyes for problems and a strong aptitude to design solutions around them.

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Thus, engineers are supposed to solve societal problems in a sustainable way. For them to do so, they need to be sufficiently informed in engineering concepts and applications of engineering theoretical principles to practical problems (Falade, 2008).

Over the past twenty five years, the University of Mines and Technology (Strategic Plan 2005-2014) (2004), with its strategic location, industrial environment, good academic facilities and capable staff has been an excellent place for training graduates of proven ability in engineering.

The University of Mines and Technology (UMaT) in Tarkwa is among the eight public Universities in Ghana. The University started as the Tarkwa Technical Institute in 1952 in 1961, it was reorganized to become the Tarkwa School of Mines to train the required manpower for the mining and allied industries in Ghana. In 1976, the School was affiliated to the Kwame Nkrumah University of Science and Technology (KNUST) as a faculty of the University and in 2001; it became the Western University College of KNUST. In November, 2004 UMaT was established as a full-fledged autonomous University by Act of Parliament of the Republic of Ghana (Act 667). Unlike the other public Universities in the Country which offer broad range of subjects in the Humanities and Sciences, UMaT focuses in the Science and Engineering Disciplines (Mireku-Gyimah, 2010).

The University currently has two faculties, i.e., Faculty of Mineral Resources Technology (FMRT) and the Faculty of Engineering (FOE). The strength of the teaching staff of the University currently stands at 79. FOE has 25 teaching staff whilst FMRT has 52 teaching staff. Available literature shows that the major challenges facing the Faculties in the University are low level of funding and the provision of modern laboratories for practical works. This has made it difficult for the faculties to keep pace with relatively rapid developments in their fields of specialization to the detriment of the students. The University is also faced with the problem of increasing student intake over the past 5 years since its inception as an autonomous University. Several difficulties have arisen in connection with managing such large classes without compromising on the quality of teaching. A notable feature is the tendency for students to share one computer or use one laboratory kit such as the Theodolite during practical or field work which affect the quality of practical work students are exposed to. This therefore means that, students have to be divided into smaller groups before they could have access to the practical work, which further means an increase in the work load of lecturers, field and laboratory technicians. With the issue of increasing students' intake and its impact on university facilities and teaching at stake, the study seeks to address the problems and find a possible solution on identifying a critical class size without compromising the quality of teaching and examinations.

STUDY METHODOLOGY

The methodology used involves the examination of available literature and the assessment of available facilities with interaction with laboratory technicians in various laboratories.

RESULTS AND DISCUSSION

Basically the general problems confronting the Faculties in the University shall be categorized into the following:

- High students intake
- Academic Facility Usage
- Teaching
- Residential Facility Usage
- University-Industry Relations

In this study, a large class will be operationally defined as a class size above 50 students.

Student intake: Statistics between the period 2005/2006 to 2010/2011 academic year shows that students' enrolment has been increasing from one academic year to another. Table 1 provides the total number of student intake over the past 5 years.

Currently the University admission policy provides a quota of admitted students per programme not exceeding 50. In view of the above concerns raised,

Table 1: Statistics on student's intake at UMaT

Department	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Geometric	34	41	39	44	40	40
Geology	31	38	44	51	45	44
Mining	33	36	38	50	46	50
Mineral	32	36	48	46	50	43
Petroleum	-	-	-	-	82	35
Mechanical	39	40	42	45	48	42
Elect. and elect	39	35	45	49	47	44
Mathematics	-	19	29	30	35	40
Computer sci.	-	-	-	-	27	33
Total	208	245	285	315	420	371

Annon, university basic statistics

Table 2: Sitting capacity of some lecture halls

Lecture theatre	Max. sitting capacity
ED I-III	50
CB I-III	50
MC I-III	30
LR I-I	160
LR II	160
LR III	180

Estate dept., UMaT; Max.: Maximum

Table 3: Common user laboratory in the university and their estimated capacity

Laboratory	Estimated capacity
Elect/electronic lab.	24
Refrigeration/air condition (dar)	20
Hydraulics	20
Tech prep	24
Process control	20
Computer-integrated manufacture	20
Pneumatic	20
Rock and soil	30
Geological lab	30
Petrology	20
Mineral processing	30
Computer science lab 1	40
Computer science lab 2	40

Estate dept., UMaT

this policy should be maintained until facilities are improved, without which the quality of teaching and learning will be in danger of being compromised. In spite of the low numbers being admitted, more funds are required to train these students pursuing the engineering discipline in the University since engineers are now regarded as unilateral leaders who should be embedded into a larger team focused on policy and development as a whole.

Academic facilities: The common academic facilities include, lecture rooms, laboratories, libraries and computer rooms.

Lecture rooms/hall: The University has lecture rooms with each having a sitting capacity not exceeding 50. However, recent development shows the construction of new lecture theatres that have sitting capacities for about 180 students. In spite of these new developments, the large lecture theatre cannot cater for combined classes for courses being undertaken by all students in a particular year. Therefore the class must be split into manageable groups for more than one sitting per lesson.

This therefore implies an additional work for technicians, laboratory assistants and lecturers handling such students for field and laboratory work. Table 2 shows a summary of some of the lecture halls and their sitting capacities. From Table 2, the lecture theatres and the sitting capacities implies that courses with large student numbers must be divided into smaller groups before they can use the available spaces. In some instances, students have to move tables and chairs from one lecture room to another.

Workshops/laboratories: Common workshops and laboratories in the University and their student intake per practicals are shown in Table 3.

Table 3, shows that the sitting capacity of each of these laboratories does not exceed 40. With such small space and the large number of students, it implies that the students have to be divided into smaller groups before each student can have access to the laboratory work. The implication is an increase in the contact hours of lecturers and laboratory technicians handling the students. Besides, facilities in these laboratories are inadequate to cater for all the students. In an interaction with the laboratory technician at the Petrology Laboratory, the indication was that students are divided into smaller groups to have access to the usage of the available microscope during laboratory work.

University library and computer room: The University has a centralized Library with a sitting capacity of about 2500 students. The library is well resourced with engineering books, periodicals and literature and reference materials. This library is patronized by all students. As the number of students increases over time, it is expected that the University Library cannot hold such huge capacity. Besides the various departments and faculties do not have library facilities to augment what the university is providing now.

With regards to the computer laboratories, the University can only boast of two which can accommodate about 40 students each. This means that for students to have access to practical computer applications, they would have to be divided into manageable groups so that they can be catered for separately at a time.

Courses with students number more than fifty: The University has a number of courses with students more than 50. For the 2010 academic year, courses like Engineering Drawing had 410 students, Fluid Mechanics, 253, Communication Skills and Introduction to Computing 410 each. Table 4 and 5 provides a list of courses with more than 50 students. The large classes are mainly the combined classes from different departments. The disturbing scenario is that these problems do not only affect first and second year students but also final year students.

From Table 2, it can be observed that there are about 20 courses in each semester with the students participating above 50. Thus with just five classrooms capable of accommodating more than 50 students, scheduling may be a challenge. The constant division of students taking the same course puts stress on both human resources and the built environment.

Teaching and examinations: In an attempt to solve the problem of large student numbers, such classes are

Table 4: Courses with students numbering more than fifty-first semester

Course number	Course title	Classes taking courses	2009/10 students number	Department managing courses
157	Communication skills	EDI-EL, MC, GM, GL, MN, MR, MA, PE, CE	410	Mining engineering
151	Applied electricity	EDI-GL, MN, MR, MC, EL, MA, PE, CE, GM	370	Electrical and electronic engineering
155	Engineering drawing	EDI-GM, GL, MN, MR, MC, PE, CE, MA	410	Mechanical engineering
159	Introduction to computing	EDI-GM, GL, MN, MR, MC, EL, MA, PE, CE	410	Computer science
161	Physical and structural geology	ED I-GM, GL, PE, MN, MR	241	Geological engineering
153	Linear algebra and trigonometry	ED I-GM, GL, MN, MR, PE	253	Mathematics
169	Linear algebra	ED I-MC, EL, CE	122	Mathematics
255	Mathematical analysis	ED I-GL, MN, MR	142	Mathematics
261	Introduction to mining	ED II-GM, GL, MR	133	Mining engineering
265	Differential equation	ED II-MC, EL	87	Mathematics
259	Geology of Ghana	ED II-GM, MN, MR	132	Geological engineering
267	Thermodynamics	ED II-MN, MC, EL	135	Mechanical engineering
263	Mine machinery	ED II-MN, MC	89	Geological engineering
295	Basic mechanics	ED II- EL, MC, GL, MN, MR, CE	5	Mechanical eng.
351	Computer application	ED III-GM, GL, MN	89	Computer science
353	Mine surveying	ED III-GL, MN	84	Mining engineering
361	Probability and statistics	ED III-GM, MN, MR, GL	163	Mathematics
359	Material handling	ED III-MN, MC	73	Mining engineering
363	Numerical analysis	ED III-MR, MC, EL	118	Mathematics
365	Environmental mgt	ED III-GM, MN, MC, EL	146	Mining engineering
451	Economic development and planning	ED IV -GM, GL, MN, MR, MC, EL, MA	228	Mining engineering
453	Law of contract and tort	ED IV-GM, GL, MN, MR, MC, MA, EL	228	Mechanical engineering
459	Operations research	ED IV-GM, GL, MN, MR, MC, EL	210	Computer science and engineering

Table 5: Courses with students numbering more than fifty-second semester

Course number	Course title	Classes taking courses	2009/10 students number	Department managing courses
152	Strength of materials	ED I-GL, MN, MR, GM, PE, EL, MC	142	Mechanical eng.
150,166	Calculus	ED I-EL, MC, GM, GL, MN, MR, PE, CE	410	Mathematics
156	Technical drawing II	ED I-GM, GL, MN, MR, MC, PE, CE, MA	410	Mechanical engineering
158	Communicative skills II	ED I-GM, GL, MR, MN, MC, PE, CE, MA, EL	401	Mining engineering
160	Mineral and petrology	ED I-GM, MR, MN	87	Geological eng
164	Basic electronics	ED I-EL, MC, CE	119	Elect. and elect. eng.
168	Materials science	ED I-MC, EL, CE	122	Mineral engineering
174,164	Principles of metallurgy	ED I-GL, MR	132	Mineral engineering
252	Literature in english	ED II-MN, MR, MC, GM, EL, MA	296	Mining engineering
260	Mathematical analysis	ED II-MC, EL	91	Mathematics
264	Fluid mechanics	ED II- GL, MN, MR, EL, MC	253	Mechanical eng.
350	Mineral resources estimation	ED III-GM, GL, MN	133	Mining engineering
352	Public relations	ED III-MN, MC, EL, GM, GL, MA, MR	89	Geological engineering
454	Business entrepreneurship	ED IV-GL, MN, MR, MC, EL, MA, GM	370	Mining engineering
458	Principles of management	ED IV-GM, GL, MN, MR	410	Mining engineering

ED: Engineering degree; GM: Geometric eng.; GL: Geological eng; MN: Mining engineering; MR: Mineral engineering; PE: Petroleum eng; MC: Mechanical eng

organized in large lecture halls with public address systems meant to enable students at the back to hear lectures being delivered. Unfortunately students find it difficult to see clearly what is written or projected on the board. Besides, the large number of students means more question time and less actual teaching time because of the large numbers who ask questions during lecture times.

Also setting of examination questions are affected since the large number of students taking the same study could mean that the lecturer must set questions that can easily be marked, thereby affecting quality and

standard of examinations. The Large number of scripts to be marked during interim assessments and end of semester examinations often become a burden on the course lecturer. This is because the University Examination policy states that the scripts should be marked within 2 weeks after examinations. In addition, security during examinations, whether class test, mid semester or end of semester examinations, can be very much compromised due to the large student numbers to invigilate. Another policy of the University is the checking of class attendance of students by course lecturers. With such a large number of students, the lecturer may spend most of the lecturing time marking the attendance register thereby affecting the time and quality of teaching.

The University should encourage the use of Teaching Assistants to assist lecturers in the management of the course especially by running tutorials and practical work. Besides, graduate students especially those who have completed the taught courses could be taken as demonstrators to assist course lecturers. The use of audio-visual aids should be encouraged in the application of teaching by academic staff so as to enhance teaching and learning. There is also the need for the University to review upwardly the remuneration for extra teaching and script marking for academic staff teaching class size exceeding 50.

Residential facility: Another major problem confronting the University has to do with the provision of residential accommodation for its students. Currently the University has two Halls of Residence that provides accommodation for only one-third of the student population. The Gold Refinery Hall accommodates a total of 250 students whiles the Chamber of Mines Hall provides accommodation for almost 350 students. This means that the rest of the students' populations are forced to search for accommodation outside the University campus.

The University has decoupled admissions and accommodation facilities and has since the 2009/10 academic year been practicing the in-out-out-out system where only first years have the right to university accommodation. With UMaT being the only public university situated in a district instead of regional capital, decent accommodation is generally expensive and difficult to come-by.

Student internship/industrial attachment: Industry is the greatest beneficiary of the products of engineering education. Therefore, it must play a major role in the production of engineering graduates. Every engineering student needs some exposure to industrial experience in the course of his stay in the University. As part of the academic structure of the University, field trips are organized for students pursuing various engineering disciplines each academic year. During long vacation most of these students would prefer to undertake practical industrial attachment. However some of these companies shy away from offering placements for the students for a number of reasons. These include high demand for work experience, provision of accommodation, transportation and out of pocket expenses for those offered placements.

Currently the University liaises with industries to offer practical attachments during long vacation to only third year students because of the non-availability of space in the various industries.

CONCLUSION

The issues of increasing student intake on the training of engineering students at UMaT have been investigated. It was realized that factors such as limited academic facilities like laboratories, lecture rooms, etc., militate against quality training. Engineering education at its highest peak is very important towards the development of the nation. With the increasing number of students each year, there is excessive pressure on physical infrastructure and the human resources available. It is important that government and stake holders in the tertiary education restructure and provide more funding for engineering education.

RECOMMENDATIONS

To contain the problem at hand the following recommendations are suggested:

Student intake: In as much as the nation needs more engineers to man its development, pressure should not be put on the University to increase the number of students with the limited available facilities and lecturers. Steps should be taken by the Government to improve the physical infrastructure, build more laboratories with modern equipments and also improve the general conditions of lecturers. When these are put in place, the intake of students can be increased.

Academic facility user: Even though students pay a portion of the Academic Facility User Fees (AFUF), a larger percentage should be borne by government. With increases in the AFUF, the University authorities can refurbish the lecture rooms, purchase adequate chairs and laboratory equipments, construct larger lecture hall etc. This will avoid the tendency of students rushing to lecture rooms to compete for the limited available spaces during lectures, avoid several students sharing a common laboratory kit etc. Departments and Faculties in the University should allocate some of their budget to provide computer laboratories and libraries to augment what the University is providing.

Residential facilities: In the wake of the increasing student population, the University administration needs to construct more hostel facilities for students. Agencies

such as Ghana Education Trust Fund (GETFund) Social Security and national Insurance Trust (SSNIT) and Volta Aluminium Company (VALCO) should be encouraged to put up more hostels on the University campus to accommodate the increasing number of students. Besides, private estate developers should be encouraged to put up more hostels.

Teaching: The University should encourage the use of Teaching Assistants to assist lecturers in the management of the course especially by running tutorials and practical work. Besides, graduate students especially those who have completed the taught courses could be taken as demonstrators to assist course lecturers in handling the undergraduate programmes.

Also the use of audio-visual aids should be encouraged in the application of teaching by academic staff so as to enhance teaching and learning. There is also the need for the University to review upwardly the remuneration for extra teaching and script marking for academic staff teaching class size exceeding 50.

University-industry relations: The University should liaise with more industries especially mining and allied industries so as to attract more funds for the construction of laboratories, residential facilities, lecture rooms, provision of equipments, etc., to improve student industrial attachment, the Universities need to liaise with the various industries to make provision to accept more students to undertake practicals in the industry. The already established and well-organized units in charge of industrial training within the industries may co-ordinate placement of students without discrimination between Universities.

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